Lowering Carbon Footprint through Improved Urban Form & Transportation Planning

Susan Culp, Sonoran Institute

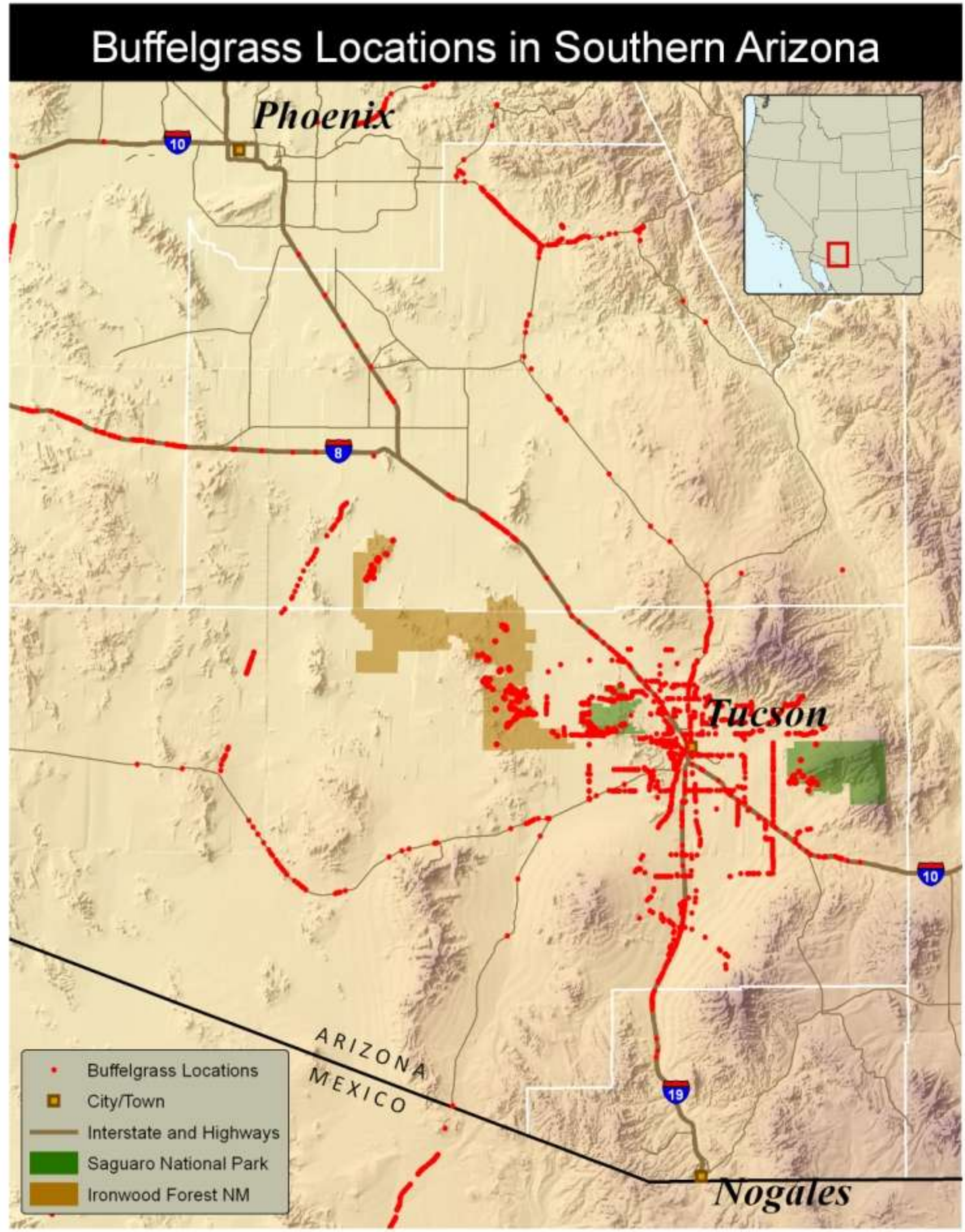
November 10, 2009

Climate Change Impacts in the Intermountain West

- Increased occurrence & severity of drought
  - Alteration in precipitation patterns
  - Reduced snowpack
  - More winter precipitation falling as rain instead of snow

- Increased wildfire risks
  - Aggravated by drought
  - Range expansion of pests (pine beetle)


Caution
High Fire Risk
Buffelgrass
Area
Learn more at
www.rmfire.com
Rural/Metro Fire Department


Buffelgrass Locations in Southern Arizona
Phoenix
10
8
Tucson
10
19
ARIZONA
MEXICO
Nogales
Buffelgrass Locations
City/Town
Interstate and Highways
Saguaro National Park
Ironwood Forest NM

- Risks have greater impact on the built environment due to increased development in the wildland-urban interface

Increased Risk of Extreme Weather Events/Other Hazards

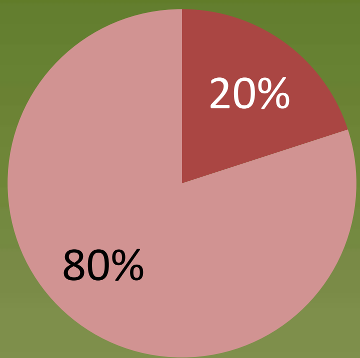
Potential Loss of Iconic Species

Local Land Use Planning is Essential to Effectively Cope with Climate Change

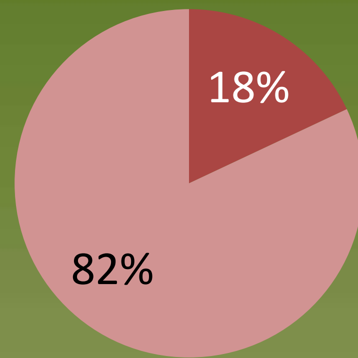
- Planning related actions can:
  - Be implemented right now – there is no need to wait for technological innovation
  - Have been shown to be effective in reducing greenhouse gas emissions
  - Carry with them a host of co-benefits
    - Cost savings for communities
    - Better quality of life
    - Improved health

Total Emissions Reductions Possible from Land-use Related Strategies

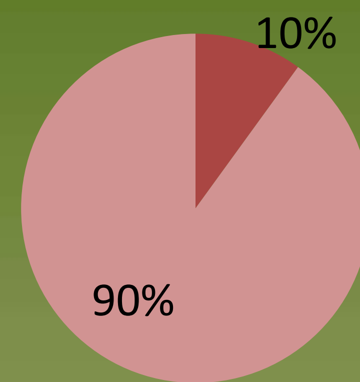
Arizona



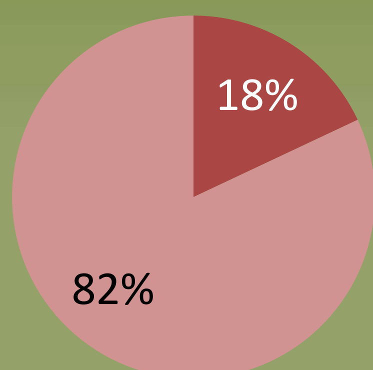
California



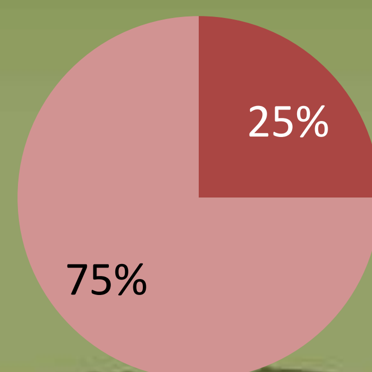
Montana



New Mexico



Washington



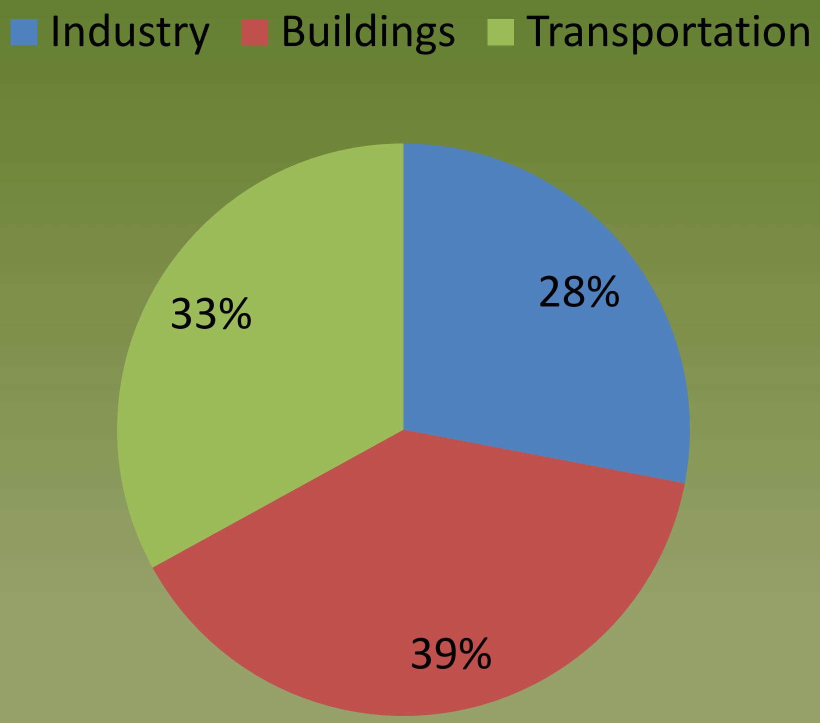
Data from Western state climate actions plans.

Carbon Emissions & Urban Form

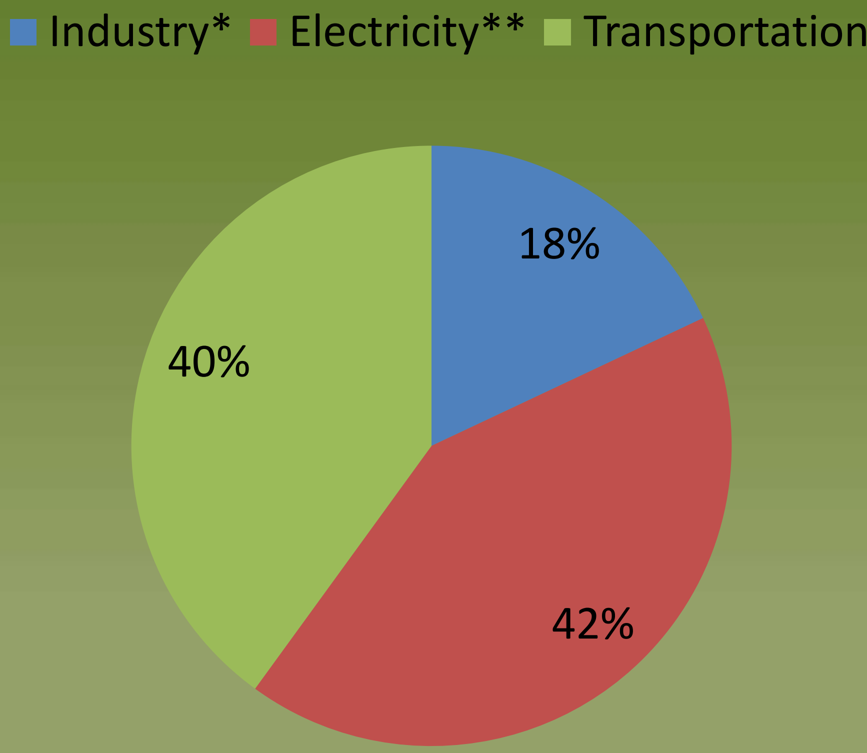
- Connection between development patterns, transportation networks, and vehicle miles traveled (VMT)
- Development patterns
  - Density, mixed-use, design
- Transportation infrastructure –providing a backbone for development patterns
- Case study for urban design to reduce VMT
  - Superstition Vistas

Greenhouse Gas Emissions by Sector

U.S. CO_2 Emissions by Sector (2005)



Arizona CO_2 Emissions by Sector (2000)



*Includes industrial processes, fuel use, waste, and agriculture.
**Includes residential & commercial fuel use.

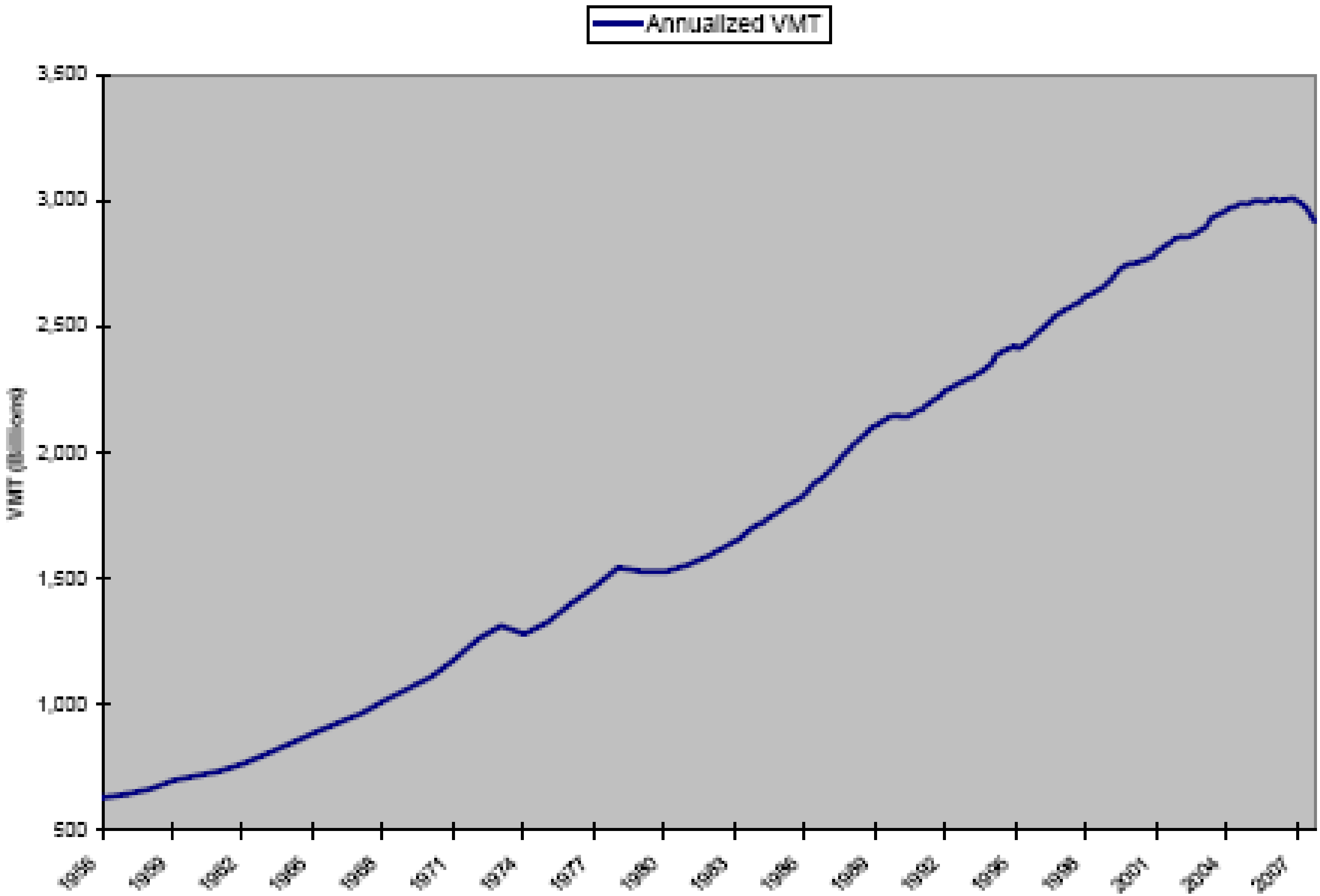
Data from U.S. EPA.

Data from Arizona State Climate Action Plan.

Vehicle Miles Traveled (VMT)

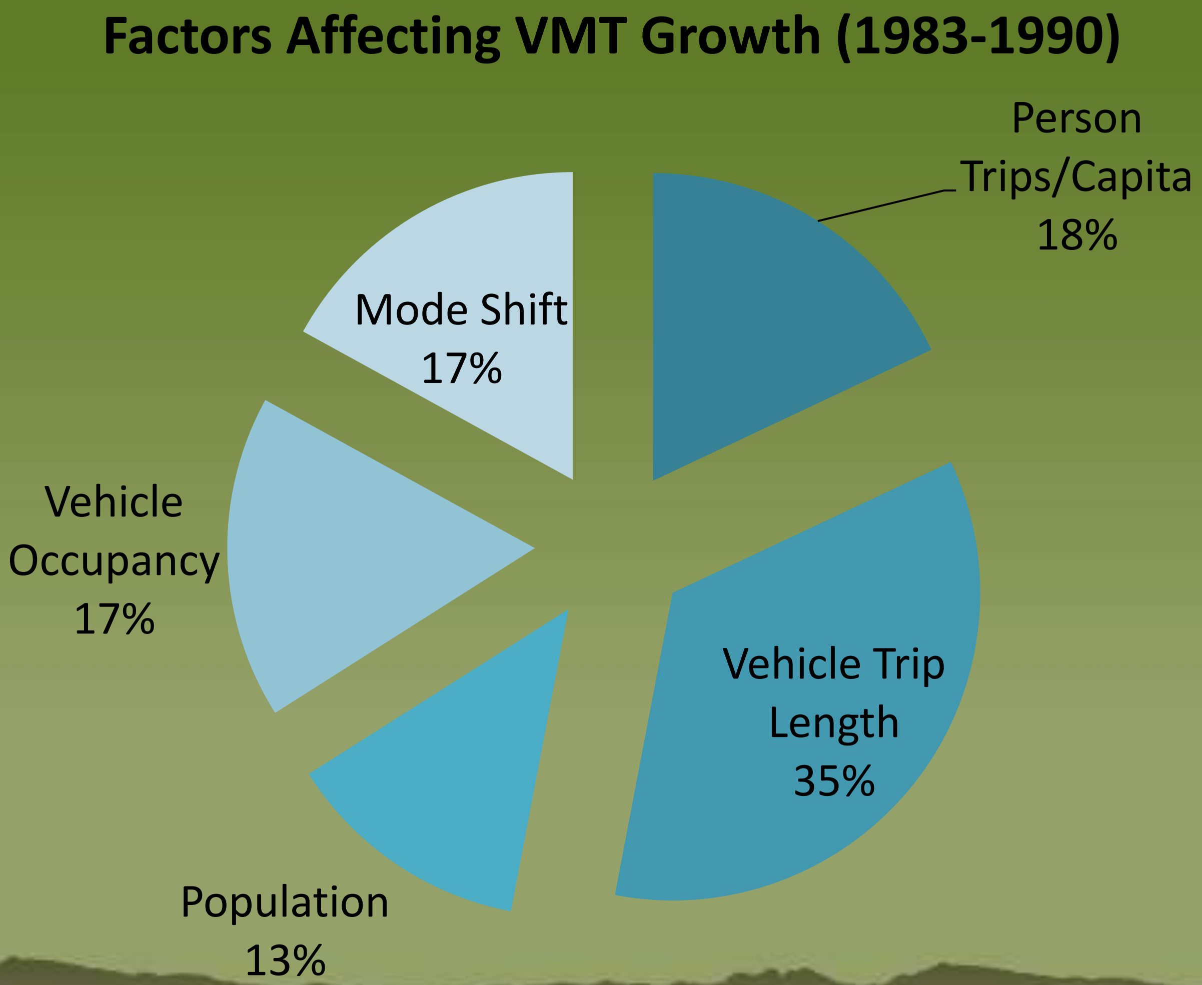
- VMT & carbon emissions – 1:1 relationship
  - Reduce VMT by 25%; reduce greenhouse gas emissions by 25%
- Reduction in VMT per capita depends on two factors:
  - How bad trend development patterns are
  - How good alternative growth patterns are
  - 5 D's (density, diversity, design, destination accessibility, and distance to transit)

Figure 1a. U.S. Vehicle Miles Traveled, Annualized, December 1956-September 2008



Source: 1956–1962: Highway Statistics, Table VM-201; 1963–September, 2008: Traffic Volume Trends

Rise in VMT Growth Over Past 3 Decades



Data from R. Ewing, et al "Growing Cooler."

Development Patterns & VMT

"Urban design can reduce VMT per capita by up to 40%"

–Pat Condon

Transportation Infrastructure – Backbone of Urban Form

Transportation Strategies to Lower Carbon Footprint

- Pricing Strategies
- Combined Land Use
- Non-motorized Transportation Networks
- Public Transportation
- HOV/Carpool/Commute Strategies
- Regulation
- Systems/Operations Improvements
- Bottleneck Relief & Capacity Expansion
- Multimodal Freight Strategies

Most Effective Transportation Strategies

Most improvement in GHG emissions

- Regulatory Measures
  - Speed limit reductions
- Pricing
  - Congestion pricing
  - PAYD
  - VMT fee
  - Carbon pricing
- Systems/Operations
  - Eco-driving
- Commuting Strategies
- Combined Land Use
- Public Transportation

Worsened GHG emissions

- Bottleneck Relief
- Capacity Expansion

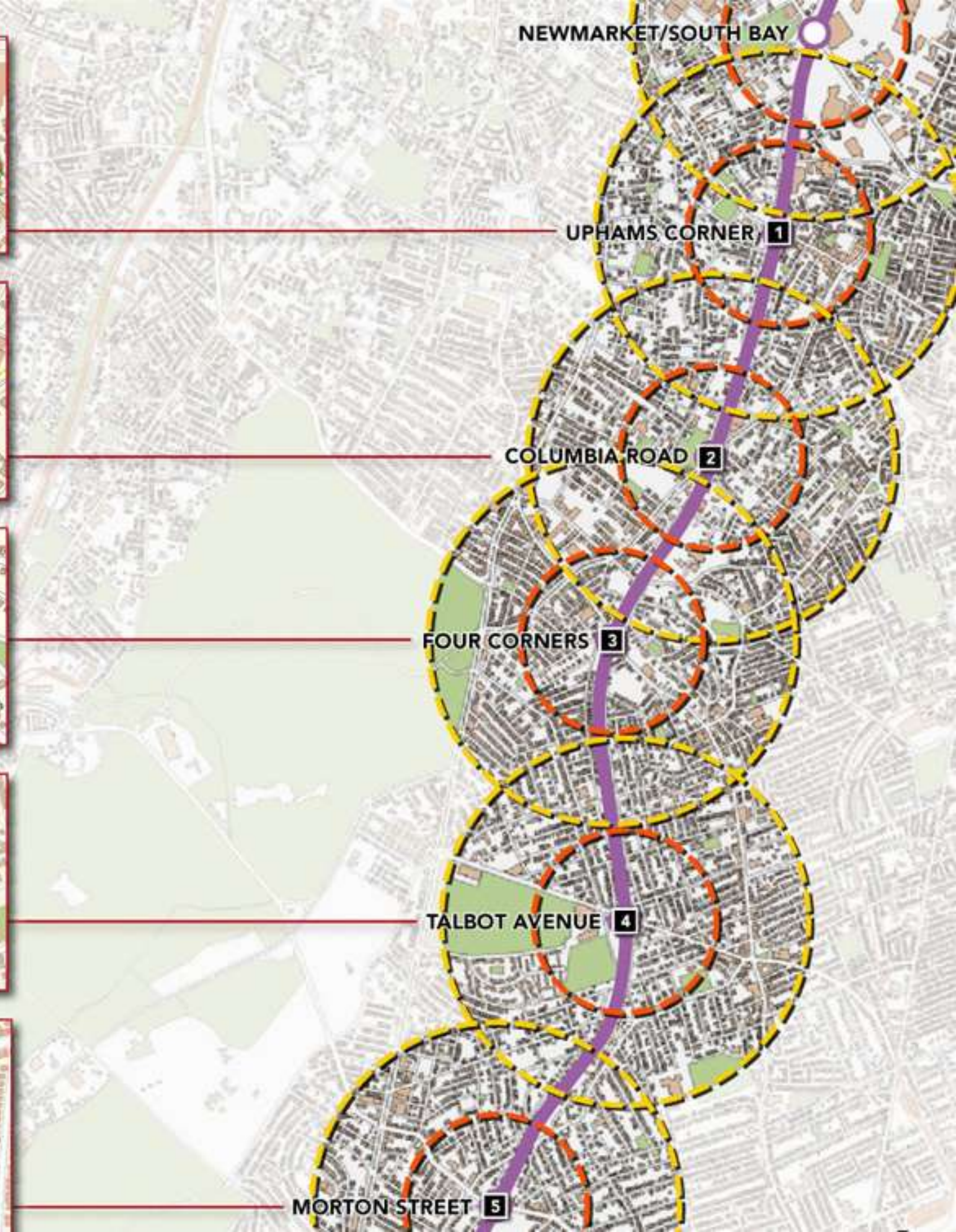
Transit-oriented mixed-use development at Uphams Corner.

New housing and businesses replace vacant and underused industrial sites at Columbia Road.

Mixed-use redevelopment to support the new station as the centerpiece of the neighborhood.

Completing a neighborhood with homes and service retail at Talbot Avenue.

Transit-oriented, compact housing and retail on a large site by Morton Street Station.



Linkage between Urban Form & Transportation

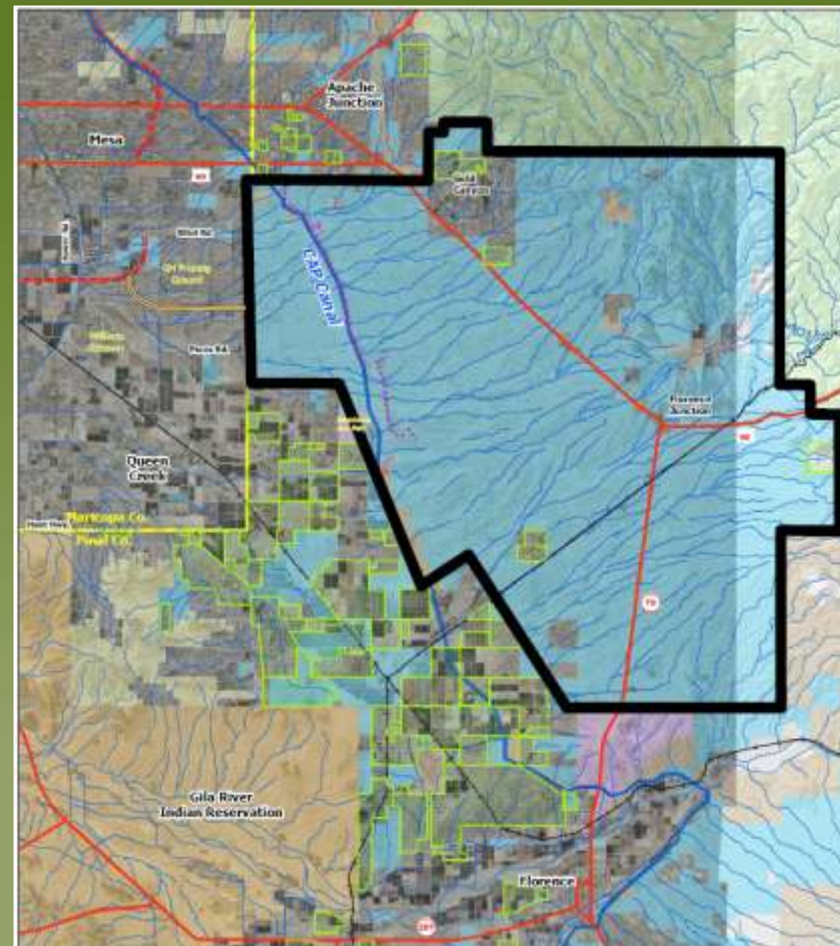
"No amount of transit investment in a vast area of low-density, single-use cul-de-sacs will be cost effective; conversely, a mixed-use, high density neighborhood with interconnected streets will still be car dependent if transit investment is lacking."

– Pat Condon, "Planning for Climate Change"

Superstition Vistas: An Arizona Case Study

Superstition Vistas Planning Area

- 275 Square miles
- Single Owner: State Land Department
- Residential population expected to exceed 1 million



Superstition Vistas Steering Committee Members

- Arizona State Land Department
- East Valley Partnership
- Pinal Partnership
- Sonoran Institute/Lincoln Institute Joint Venture
- Salt River Project
- Resolution Copper
- Adjacent Jurisdictions
  - City of Apache Junction
  - City of Florence
  - Pinal County
  - City of Mesa
  - Town of Queen Creek
  - Maricopa County
- Banner Health

Superstition Vistas Planning Project Consulting Team

Robert Grow consulting

Fregonese Associates

HarrisInteractive

RCLCO Robert Charles Lesser & Co.

EDAW | AECOM

Kimley-Horn and Associates, Inc.

Mission of Superstition Vistas Project

The Superstition Vistas area represents an unprecedented opportunity to become a global model for sustainable communities over a 50-year planning horizon. The goal is to ***create vibrant communities with a sense of place anchored by community values establishing Arizona as a leader in sustainable development***.

Develop a Range of Scenarios

A

B

C

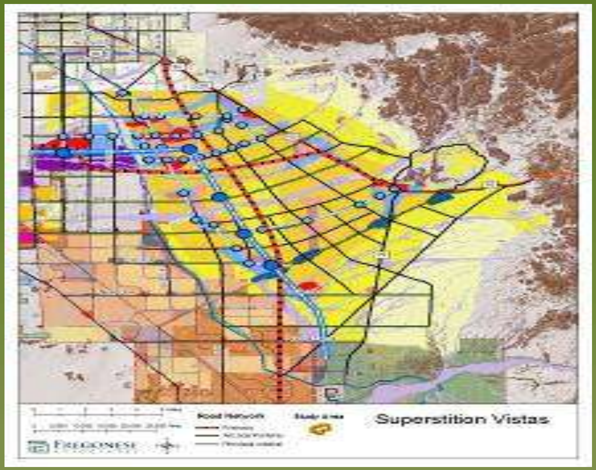
D

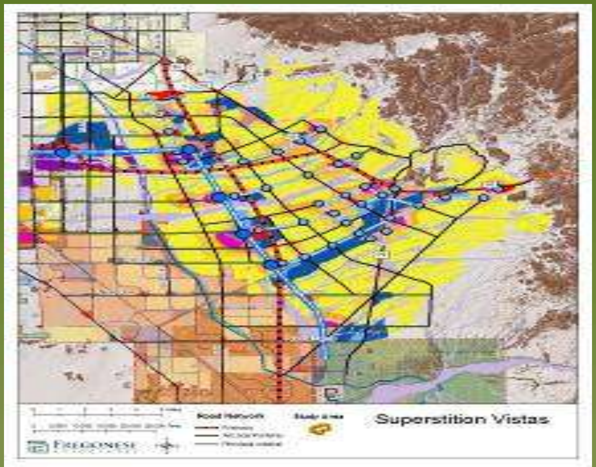
Envision Tomorrow Modeling

1) Develop a series of prototype buildings (ranging from single-family detached to office complexes and industrial buildings)
2) Aggregate the building types into “development types” (urban downtown core, mixed-use main streets, low density residential subdivisions)
3) Development types were then painted onto the landscape using Envision Tomorrow Scenario Builder with Arc-GIS to show regional level growth patterns

Scenarios for Superstition Vistas

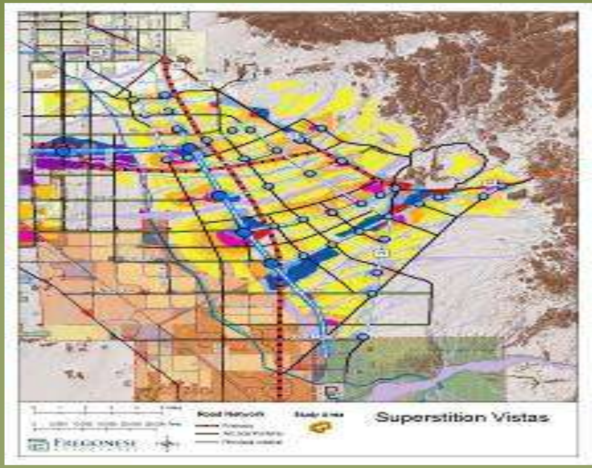
A

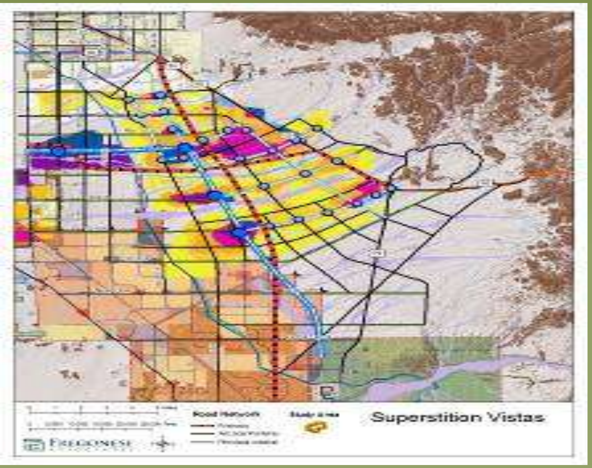




B

C





D

Indicators List

Superstition Vistas
Scenario Indicators

3/20/2009

Superstition Vistas

	Scenario A		Scenario B		Scenario C		Scenario D	
	Total	Percent	Total	Percent	Total	Percent	Total	Percent
Building Energy Indicators								
Building Energy Usage								
Annual Electrical Requirement (kWhr/yr)								
Baseline	10,913,048,145		11,231,883,319		8,505,752,958		6,699,390,235	
Good	7,701,295,554		7,906,216,060		5,929,667,718		4,659,032,625	
Better	5,168,969,715		5,305,008,099		4,098,615,745		3,356,691,047	
Best	1,819,231,393		2,252,188,103		1,802,201,875		1,646,321,936	
Annual Gas Requirement (Therms/yr)								
Baseline	300,832,081		277,139,708		211,119,639		159,388,366	
Good	217,244,630		207,922,031		163,995,699		124,527,541	
Better	173,803,725		168,984,931		130,137,409		97,230,024	
Best	117,894,645		99,239,366		78,461,810		60,407,279	
Building Emissions (CO2)								
Annual CO2 (ton/yr)								
Baseline	6,849,963		6,432,108		4,979,872		3,946,321	
Good	4,857,101		4,574,143		3,542,903		2,797,772	
Better	3,411,627		3,251,780		2,556,985		2,046,724	
Best	1,437,773		1,414,298		1,158,182		964,222	
Building Energy Costs								
Annual Energy Costs								
Baseline	$ 1,493,535,629		$ 1,517,102,290		$ 1,145,803,160		$ 891,765,906	
Good	$ 1,058,401,936		$ 1,082,055,138		$ 818,264,057		$ 636,594,670	
Better	$ 741,690,706		$ 756,203,103		$ 582,339,834		$ 466,317,077	
Best	$ 338,742,440		$ 369,623,175		$ 292,840,567		$ 255,867,129	
Incremental Costs								
Baseline	0		$ -		$ -		$ -	
Good	$ 2,032,216,559		$ 2,336,889,022		$ 1,730,440,874		$ 1,301,717,310	
Better	$ 7,380,322,607		$ 8,705,440,633		$ 6,476,717,527		$ 4,652,496,109	
Best	$ 18,169,376,063		$ 19,149,888,609		$ 14,563,728,387		$ 10,355,098,583	
Total Carbon Footprint (Building and Transportation Emissions)								
Baseline	9,446,329		8,288,903		6,820,932		5,378,257	
Good	6,359,284		5,848,432		4,606,088		3,626,249	
Better	4,365,394		3,933,868		3,233,293		2,572,741	
Best	2,021,955		1,832,077		1,573,420		1,286,407	

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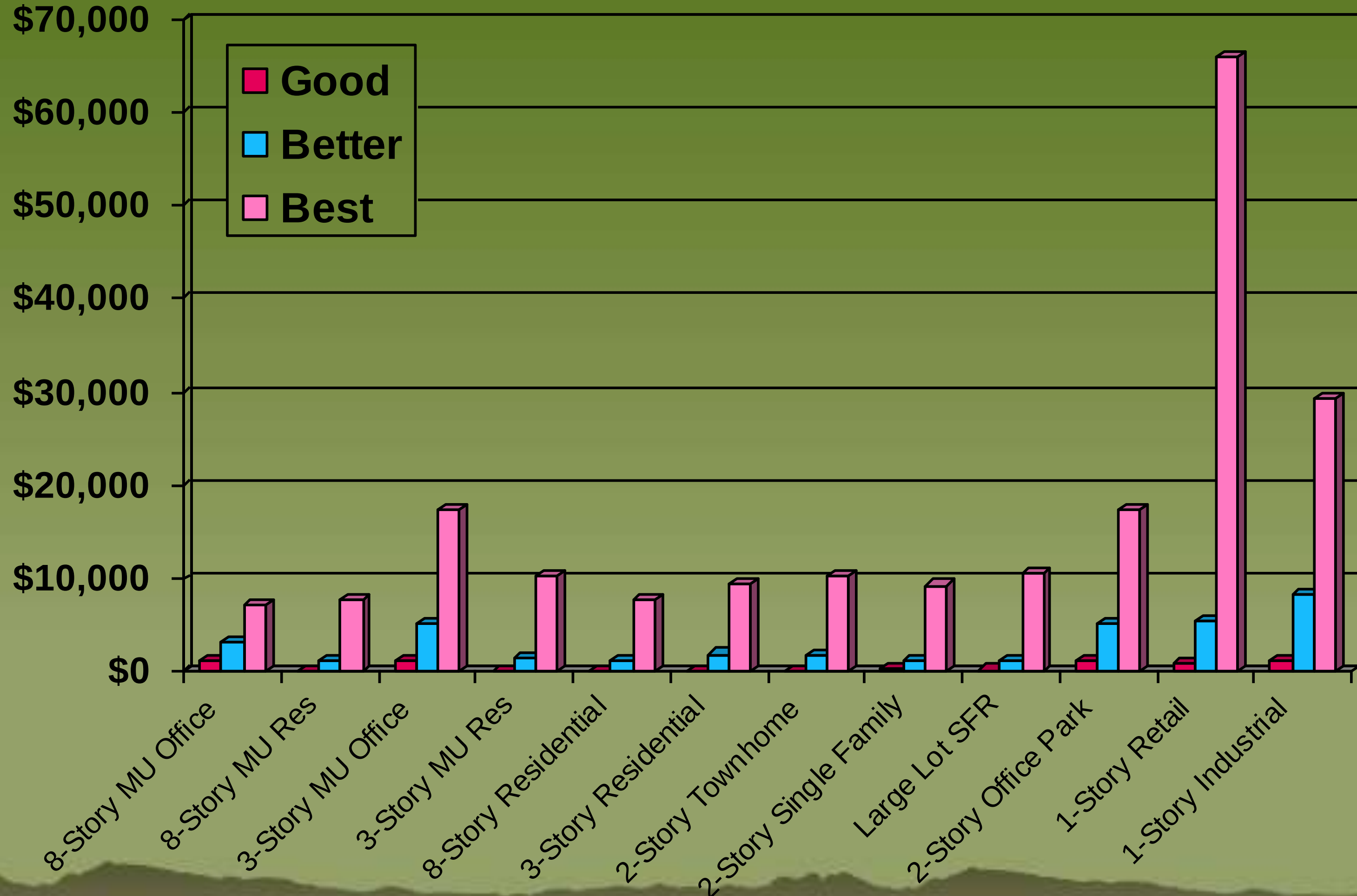
Lesson 1:
Building in a "greener" fashion is a key strategy

- Land use and transportation are important in "going green"…
- But "greener" buildings and landscaping are very effective at reducing greenhouse gas emission, energy consumption and water use
  - **Can reduce building emissions by 85%**
  - **Can reduce transportation emissions by 87%**
  - **Can reduce landscaping water by 86%**
- By aggressive land use and better building codes
- Promote auto efficiency

Focus on Residential Buildings

Incremental Cost per Pound of CO2 Usage



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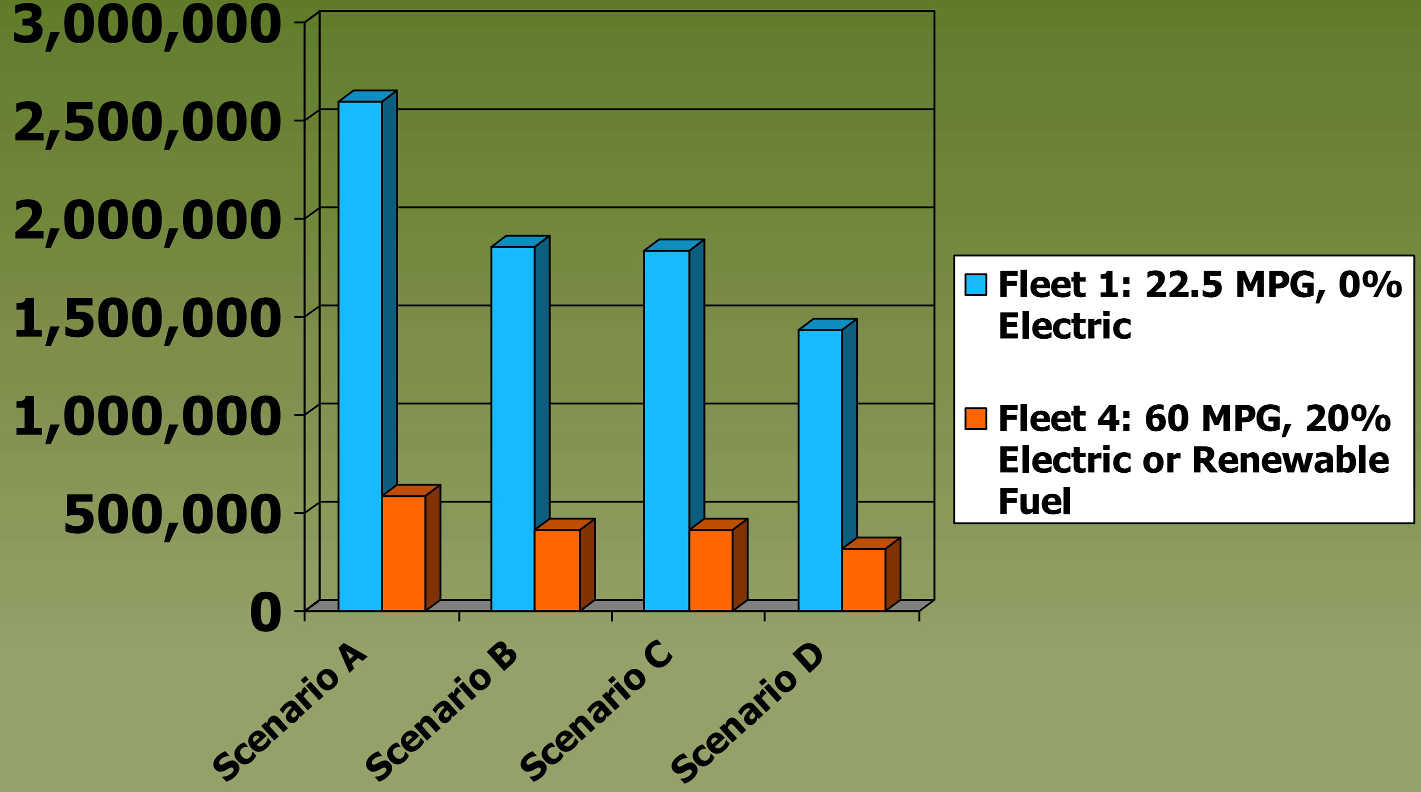
Transportation Emissions (CO2)

Tons of CO2 per year



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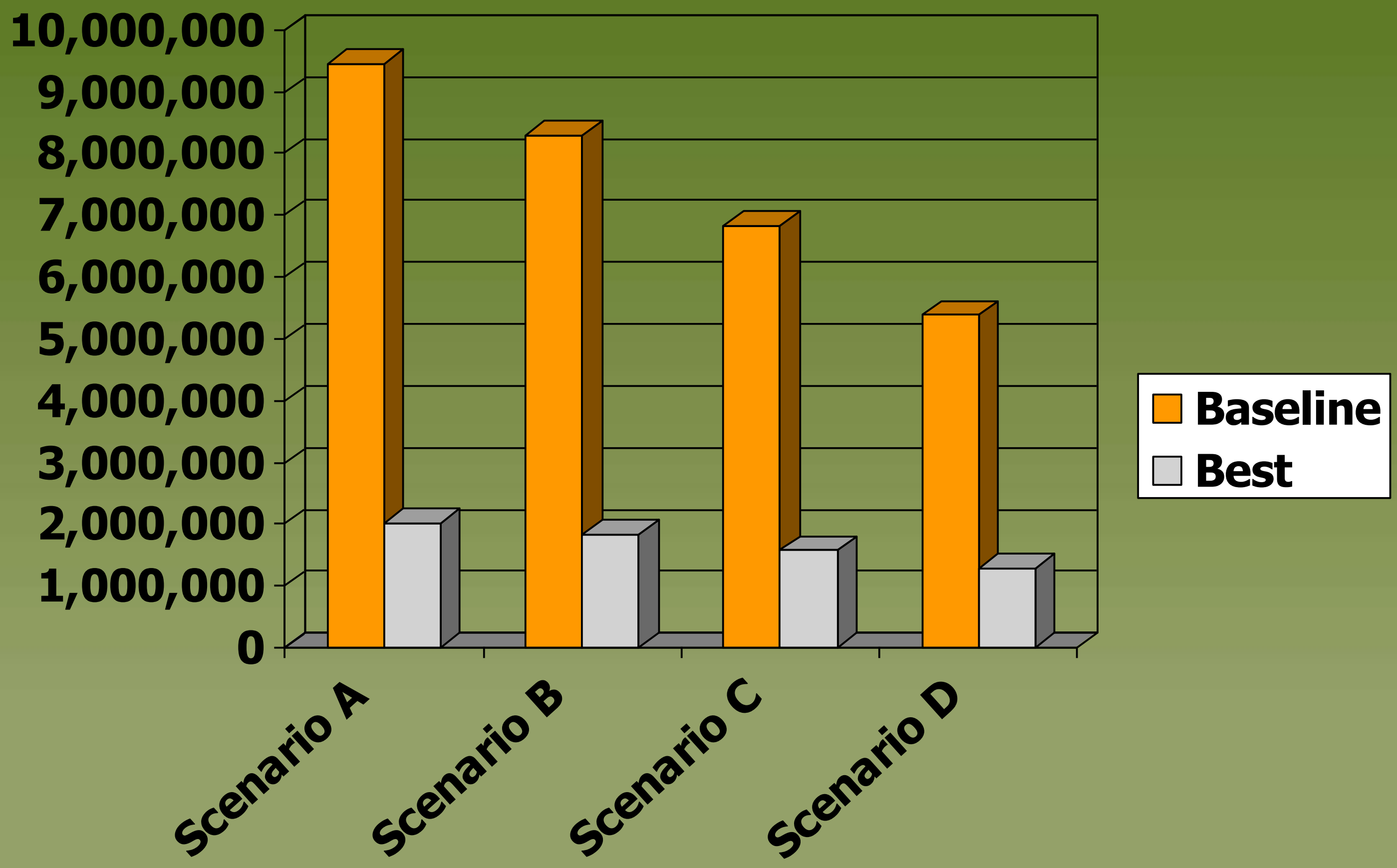
Lesson 2:

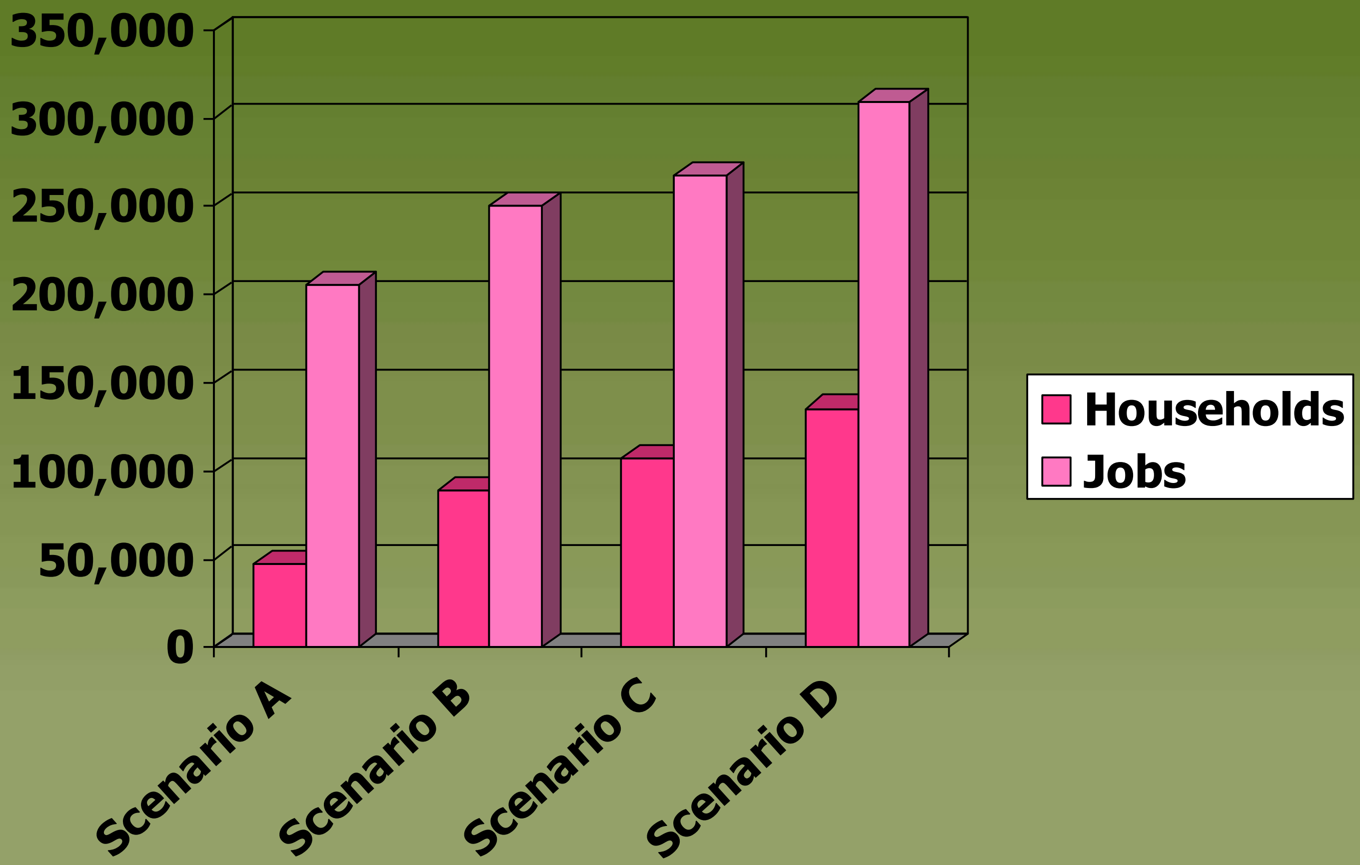
A more compact urban form reduces carbon impact and water consumption while accommodating the same population forecast

- Higher density building forms are more energy efficient
- Common walls and less building area per capita
    - **A reduction of 39% from building related emissions.**
    - **A reduction of 40% from transportation savings from more efficient land use**
    - **A reduction of 50% in water consumption**

Total Carbon Footprint
(Building and Transportation Emissions)



Proximity to Transit



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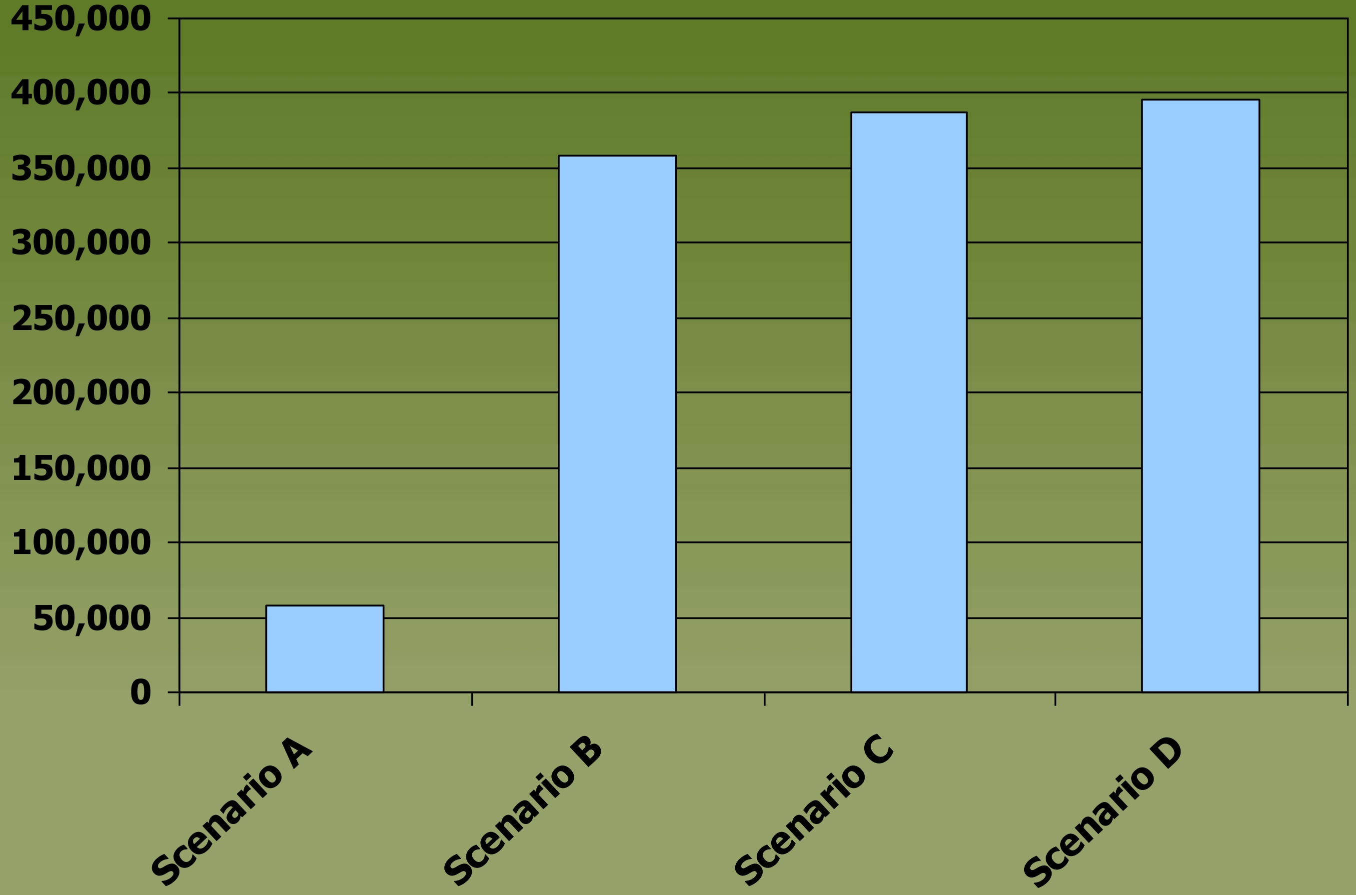
Daily Transit Ridership



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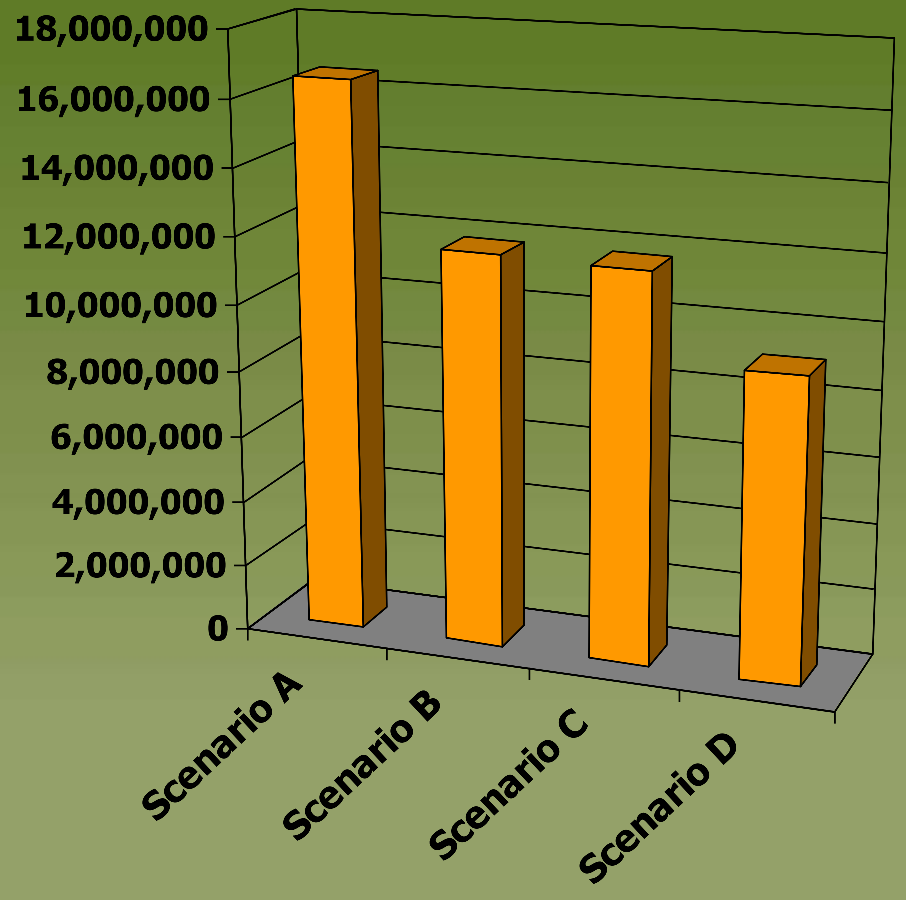
Vehicle Miles Traveled



Lesson 3:

Achieving a better jobs housing balance is a key to transportation carbon emission reductions

- Low carbon footprint from transportation sources will be difficult without a successful economic development program
- Housing affordability is important in supporting full cross-section of workers
- Higher jobs/housing ratio is largely responsible for the dramatic reduction in vehicle miles traveled
  - Scenario A recorded 16,500,000 daily miles, Scenario B recorded 11,800,000 daily miles
  - A 28% reduction in VMT, from more local work, and transit oriented development
  - Scenario D was only 23% better than B despite being much denser

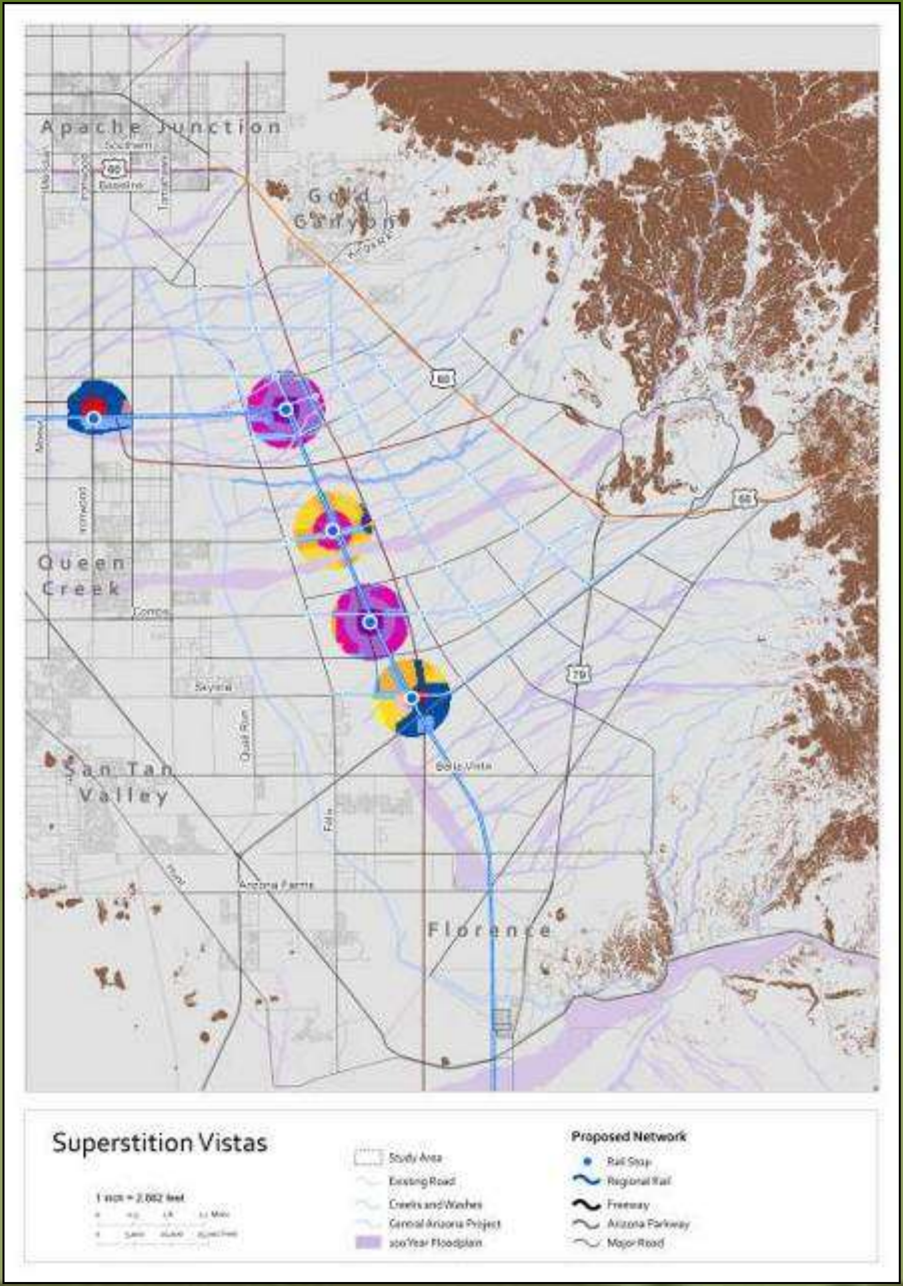
Lesson 4:

Designing a city with appropriately spaced and well designed mixed use centers is more important than density alone

- Density in itself does not reduce travel demand, but jobs-housing balance and mixed use design does.
- Scenario B had almost all the advantages of C except density, and at least for transportation carbon footprint, performed almost as well.
- Scenario B and C had approximately the same urban design and transit ridership
- The impact on travel was negligible, because the bulk of the housing and jobs were in the centers, or within transit or walking distance of the centers

Applying the Lessons

- Creating mixed use centers around major transportation corridors is a primary driver of improved VMT & carbon emissions reductions
- Plan a range of mixed use centers around transit
  - A few regional centers
  - Many neighborhood centers
  - Close access to centers throughout the Vistas



Grow the Transit with the Community

- – Plan for rail
- – Start with BRT
- – Ramp up bus frequency on corridors over time

Thank You!

Susan Culp

(602) 393-4310; sculp@sonoraninstitute.org

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